# FINAL
# REMEDIAL INVESTIGATION AND FEASIBILITY STUDY (RI/FS) FOR THE LANDSBURG MINE SITE

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on behalf of:

The Landsburg PLP Steering Committee

for:

The Washington State Department of Ecology

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## EXECUTIVE SUMMARY

This report, prepared by Golder Associates Inc. (Golder) for the Landsburg Mine Potentially Liable Parties Group (PLP Group), presents the results of the Remedial Investigation (RI) and Feasibility Study (FS) for the Landsburg Mine site. The Landsburg Mine site is a State of Washington Priority Listed site under the auspices of the Model Toxics Control Act (MTCA), Chapter 70.105D RCW. Pursuant to the Washington State Department of Ecology's authority under MTCA, Ecology issued Agreed Order No. DE 983TC-N273 (WDOE 1993a) on July 21, 1993, which directed the Landsburg PLP Group to conduct this RI/FS. This RI/FS report has been prepared in accordance with the Agreed Order, the *Landsburg Phase I Remedial Investigation/Feasibility Study (RI/FS) Work Plan* (Golder 1992a), and the requirements of WAC 173-340-350 State Remedial Investigation and Feasibility Study. This RI/FS will be used to support final remedy selection as documented in the Cleanup Action Plan (CAP) for the site.

### REMEDIAL INVESTIGATION

The Landsburg Mine site is a former underground coal mine located approximately 1.5 miles northwest of Ravensdale in southeast King County, Washington. The Cedar River passes within approximately 500 feet of the site to the north. The mine site occupies property owned by Palmer Coking Coal Company (PCC) and Plum Creek Timber Company, L.P. PCC operated an underground coal mine known as the Landsburg Mine from the late 1940s until approximately 1975. The Rogers Seam was mined from 1959 until 1975. The mined section of the Rogers coal Seam has a near vertical dip and consists of coal and interbedded shale approximately 16 feet wide. The mined section is about a mile in length. Mining occurred at depths of up to 750 feet using a mining method locally called "booming" which followed the coal seam vertically. As a result of underground mining of the Rogers Seam, a subsidence trench developed on the land surface above the mine workings. The dimensions of the trench vary, from about 60 to 100 feet wide, between 20 to 60 feet deep, and about 3/4 mile long.

Based on currently available information, this trench was used in the late 1960s to the late 1970s for disposal of various industrial waste materials, construction materials, and land-clearing debris. Drums, liquid from tanker trucks and other industrial materials were disposed of in the northern portion of the trench. Disposal of land clearing debris continued until the early 1980s. Currently, the site is secured by a fence and locked gate which encloses the northern portion of the trench where disposal occurred.

Several preliminary environmental investigations have been performed at the site (Geraghty and Miller 1990; Applied Geotechnology 1990; Washington State Department of Health 1992). During these preliminary investigations, hazardous substances were not detected in area private and public supply wells, mine portal groundwater discharges or soil gases.

Due to continued concerns over potential environmental hazards posed by the Mine, however, Ecology commissioned a Site Hazard Assessment (SHA) study in 1991 (Ecology and Environment 1991). Ecology then requested potentially liable parties (PLPs) to perform an expedited response action (ERA) which resulted in the removal of over 100 exposed 55-gallon drums from the trench (Landsburg PLP Steering Committee 1991). These investigations found hazardous substances, including volatile and semi-volatile organic compounds, PCBs, cyanide and metals, in drum contents, adjacent soils and ponded surface water within the northern portion of the trench where prior waste disposal occurred.

On the basis of these results, Ecology and the PLP Group entered into an Agreed Order (WDOE 1993a) which directed the PLP Group to conduct an RI/FS to evaluate the need for remedial action. The scope of work for the RI was outlined in the *Landsburg Phase I Remedial Investigation/Feasibility Study (RI/FS) Work Plan* (Golder 1992a) which was incorporated by reference into the Agreed Order. The approach taken during the RI was to focus environmental sampling efforts on potential pathways of chemicals leaving the mine and not on wastes present within the mine itself. Investigation of wastes in the mine was limited due to physical constraints and dangers, and difficulties associated with taking samples in the mine. Data collection activities conducted under the RI included the following primary tasks:

- **Air Monitoring.** A series of air surveys was conducted down the centerline of the trench to monitor for the presence of organic vapors which could be associated with waste disposal.

- **Source Characterization in Rogers Trench (Geophysical Investigation).** A magnetometer survey was conducted along the centerline of the Rogers Seam trench to identify areas of potential buried waste.

- **Private Well Survey.** A well survey was conducted to identify private and public wells within the Study Area, and to support the selection (in consultation with the State Department's of Health and Ecology) of wells for quarterly sampling.

- **Monitoring Well Drilling and Installation.** Seven new monitoring wells (LMW-1 through -7) were installed at the site. Wells LMW-2/4 and LMW-3/5 consisted of nested well pairs installed within the coal at each end of the trench at the points of expected mine groundwater discharge. LMW-1 was installed overtop a suspected location of a fault and tunnel connecting offset portions of the Rogers Seam. Wells LMW-6 and -7 were installed in adjacent coal seams (Frasier and Landsburg Seams) to provide indications of water quality typical of adjacent coal seams. Angled drilling methods were used at the LMW-4 and LMW-7 well locations to intercept the vertical coal seam.

- **Quarterly monitoring of surface water and groundwater.** Surface water associated with Rogers Mine portals #2 and #3, and groundwater from the seven site wells and from 14 selected area private wells were sampled for chemical analysis over four rounds of quarterly sampling. The samples were submitted for a broad range of chemical analyses including metals and cyanide, volatile and semi-volatile organics, pesticides and PCBs, and general chemical parameters.

- **Surface Soil Sampling.** Surface soils around the trench rim perimeter and downslope of portal #3 were sampled for chemical analysis.

- **Topographic Survey and Geodetic Control.** Using aerial photogrammetry techniques, a topographic base map of the site was prepared to 2 ft contours. Horizontal control was established based on the Washington State Plane Coordinate System as required under MTCA.

On the basis of the RI data, the following primary conclusions were reached:

**Nature and Extent of Chemicals in the Environment.** Chemicals associated with the prior waste disposal activities at the site do not appear to be exiting the mine (Section 5.4). Extensive sampling of air, soil, groundwater and surface water at the site have indicated that chemicals associated with the waste are limited only to soils located within that portion of the trench known to have been used for prior waste disposal; levels of chemicals throughout the remainder of the Study Area are consistent with typical background conditions.

**Source Characteristics.** Geophysical data, the results of sampling and historical information indicate that any potential remaining wastes in the trench appear to be confined to the northern half of the trench in the areas utilized for waste disposal (Section 3.2). The nature of these potential remaining waste materials is uncertain beyond that which is known regarding what was disposed in the trench. Wastes remaining could include some intact and partially intact drums buried beneath the trench bottom surface at some depth. However, based on the condition of the drums observed in the ERA, the duration of burial, physical damage known to occur during placement, etc., the vast majority of the drums have probably already ruptured or deteriorated in some manner.

**Potential Future Pathways of Chemicals Exiting the Mine.** As part of the RI, it was necessary to evaluate the *potential* pathways for chemical migration from the mine. The groundwater pathway represents the most significant potential pathway (Section 3.6.4). Waste present in the trench is believed to be confined to the northern half of the site. Groundwater flow beneath this portion of the site is to the north through the mined out and highly permeable Rogers Seam. Flow laterally away from the mine is negligible due to the tightness of faults and the vertical orientation and layering of low-permeability strata. The primary pathway of chemicals potentially exiting the mine is through the Rogers seam to the north. Future groundwater monitoring activities should focus on the detection of potential releases from the north end of the mine. The chance that such a discharge could occur at the southern end is unlikely given the direction of groundwater flow and the absence of waste in this portion of the mine.

Once exiting the site, any potential chemical constituents leaving the northern portion of the mine would flow primarily to the north and northeast towards the Cedar River, consistent with the local ground surface topography (Figure 3-24). This flow would occur within the Rogers coal Seam and within the glacial outwash materials which overlie the coal. No drinking water wells are currently located along this primary pathway of groundwater flow. The two monitoring wells (LMW-2 and -4) located along this pathway did not show any evidence of contamination during the RI.

While the primary flow direction is towards the river, it is also possible that some flow could occur to the northwest within the glacial outwash deposits located to the north of the mine. If groundwater were to flow in this direction, potential receptor points would include the wells located to the northwest of portal #2 along the Summit-Landsburg Road. Well PW-4 is the closest well and is approximately 1,500 ft away from the trench. It is not considered likely, however, that groundwater flow would occur to these wells given the strong topographic gradient towards the river.

At the southern end of the mine, potential receptors include the cluster of wells along the Kent-Kangley Road just southwest of portal #3, and the Clark Springs facility. The Clark Springs facility is approximately 2,500 ft from the portal. It is not likely that these wells would ever be impacted, however, as discharge of chemicals from the mine's southern end is a remote possibility.

**Applicable or Relevant and Appropriate Requirements (ARARs).** The primary potential ARARs for the site include the following (Chapter 4):

- Model Toxics Control Act (MTCA) RCW 70.105D and MTCA Cleanup Regulations WAC 173-340; and
- Minimum Functional Standards for Solid Waste Handling WAC 174-304.

In addition, portions of the dangerous waste regulations (WAC 173-303) may be relevant and appropriate.

**Adequacy of RI Data**. The data collected under this Remedial Investigation are considered adequate to characterize site conditions and to support evaluation and selection of a preferred remedial alternative in the FS. This document, therefore, represents a complete and final RI and FS set of documents that will be sufficient to enable Ecology to make decisions regarding the final Cleanup Action Plan (CAP) for the site.

## FEASIBILITY STUDY

The Feasibility Study (FS) for the Landsburg Mine site consists of the following elements:

- **Development of remedial action objectives.** Objectives and cleanup levels are established that provide the basis for developing and evaluating alternatives for remediation of the site.
- **Identification and screening of remediation technologies.** Candidate technologies are screened to obtain a list of feasible technologies for use in assembling remediation alternatives.
- **Identification and screening of remediation alternatives.** Remediation technologies are assembled into a wide range of alternatives for remedial action at the site. The

alternatives are then screened to obtain a focused list of alternatives for further consideration.

- **Development and evaluation of remediation alternatives.** Alternatives remaining after screening are further developed and subjected to detailed evaluation. Consideration of the evaluation results in a preferred alternative for the site.

**Remedial Action Objectives**

Remedial action objectives (RAOs) are site-specific goals based on acceptable exposure levels that are protective of human health and the environment and consider applicable or relevant and appropriate requirements (ARARs). Remedial action objectives identify risk pathways that remedial actions should address, and identify acceptable exposure levels for residual constituents of concern. The remedial action objectives for this site are:

- Minimize the potential for future direct exposure of human or ecological receptors to any waste constituents that may remain at the site.

- Reduce the potential for migration of any waste constituents from the trench in groundwater, surface water or airborne dust.

**Identification and Screening of Remediation Technologies**

Potentially applicable remediation technologies have been identified for each of the general response actions. Technologies have been considered for each of the following categories:

- Institutional controls (including monitoring)
- Containment
- Removal
- Ex-Situ Treatment (including reuse and recycling)
- In-Situ Treatment
- Disposal

The technologies have been screened based on effectiveness, implementability, and cost to obtain a set of technologies that could be applied at the Landsburg Mine site.

**Identification of Remediation Alternatives**

Remediation technologies retained following the screening process are then assembled into remediation alternatives. The technologies are combined to create a wide range of alternatives that represent various approaches to achieving remedial action objectives. Remediation alternatives are developed to meet the following MTCA requirements:

- Protect human health and the environment,

- Comply with cleanup standards,

- Comply with applicable laws and regulations,
- Provide for compliance monitoring,
- Use permanent solutions to the maximum extent practicable, and
- Provide for a reasonable restoration time frame.

Consideration of public concerns is performed by Ecology after the FS is completed and is based on public comments on the draft Cleanup Action Plan (CAP). Public concerns may result in modifications to the remedial action proposed in the draft CAP. Any modifications would be incorporated into the final CAP.

The following alternatives were developed for remediation of the Landsburg Mine site:

**Alternative 1: No Action.** A "no action" alternative is included as a baseline for comparison to the other alternatives. This alternative would leave the site in its current state, assuming no restrictions on future site use and no site maintenance or monitoring.

**Alternative 2: Institutional Controls and Monitoring.** Institutional controls include deed restrictions, fencing and warning signs, and groundwater use restrictions, as well as periodic site inspections and maintenance of the physical components of the controls. Groundwater use restrictions would be employed to prevent exposure to site groundwater. Thus, if site groundwater were to become affected by waste constituents, there would be no immediate exposure. Exposure could occur only following off-site migration. Routine, periodic monitoring would detect constituents of concern in groundwater were it to become affected.

**Alternative 3: Trench Backfill.** This alternative would protect human health and the environment by providing long-term containment of any waste and affected soil in the trench. This alternative would consist of filling the trench in the area where waste disposal occurred, combined with grading to provide proper stormwater drainage and prevent stormwater collection in the trench area. Institutional controls and periodic maintenance and monitoring would also be included.

**Alternative 4: Soil Cap.** This alternative would protect human health and the environment by providing reliable long-term containment of any waste and affected soil in the trench. As with Alternative 3, the trench would be filled only in the area where waste disposal occurred, combined with grading to provide proper stormwater drainage and prevent stormwater collection in the trench area. The backfill would be covered by a soil cap to provide additional protection, and add a thicker vegetated soil layer for improved evapotranspiration and erosion control. Institutional controls and periodic maintenance and monitoring would also be provided.

**Alternative 5: Low-Permeability Soil Cap**. This alternative is very similar to Alternative 4, except that a low-permeability liner, constructed by compacting suitable soil, would be included in the cap design to decrease the amount of infiltration through the cap, thus decreasing the potential for affecting groundwater. Institutional controls and periodic maintenance and monitoring would also be provided.

**Alternative 6: FML Cap**. This alternative is very similar to Alternative 5, except that the low-permeability liner would be constructed using a synthetic flexible membrane liner (FML) instead of compacted soil. Institutional controls and periodic maintenance and monitoring would also be provided.

**Alternative 7: FML/GCL Cap.** This alternative is very similar to Alternative 6, except that a geosynthetic clay liner (GCL) would be added to provide two low-permeability liners instead of one. Two liners do not provide lower infiltration than a single liner, but provide additional reliability for long-term protection. Institutional controls and periodic maintenance and monitoring would also be provided.

**Alternative 8: Excavation and Off-Site Disposal of Surficial Affected Soil and Capping.** This alternative would consist of removal of surficial soil in the trench containing concentrations of constituents of concern above remediation goals followed by off-site disposal. The trench would then be backfilled and graded for proper stormwater drainage. Because waste and affected soil would presumably remain buried in the trench, a cap meeting minimum functional standards under WAC 173-304 would be placed over the trench. Institutional controls and periodic maintenance and monitoring would also be provided.

**Alternative 9: Excavation and Off-Site Disposal of All Waste and Affected Soil.** In this alternative, all waste and affected soil would be removed from the trench for off-site disposal. Appropriate disposal facilities would be used, depending on the waste designation (hazardous, dangerous, or non-hazardous). Institutional controls, maintenance, and monitoring would not be necessary for this alternative because all waste and affected soil would be removed from the site.

## Screening of Alternatives

The remediation alternatives summarized above were evaluated based on effectiveness, implementability, and cost. Based on the screening evaluation (Section 7.3.3), the following alternatives were retained for detailed development and evaluation:

Alternative 1: No Action
Alternative 2: Institutional Controls and Monitoring
Alternative 4: Soil Cap
Alternative 5: Low-Permeability Soil Cap
Alternative 6: FML Cap
Alternative 7: FML/GCL Composite Cap
Alternative 9: Excavation and Off-Site Disposal of All Waste and Affected Soil.

## Threshold Requirements

Under MTCA, remediation alternatives must meet the following threshold requirements (WAC 173-340-360(2)):

- Protection of human health and the environment
- Compliance with cleanup standards

- Compliance with ARARs
- Provision for compliance monitoring

For reasons discussed in Section 9.1, the following alternatives do not meet one or more of the MTCA threshold criteria for selection as the preferred alternative:

Alternative 1 (No Action)
Alternative 2 (Institutional Controls and Monitoring)
Alternative 4 (Soil Cap).

These alternatives are retained for the full evaluation, however, because their inclusion provides perspective on the benefits and costs of the alternatives, much as the "no action" alternative provides a baseline for comparison. It is minimal additional effort to include the alternatives in the full evaluation, and excluding them would not change the evaluation scoring or preferred alternative.

The remaining alternatives 5, 6, 7 and 9 meet the minimum requirements of the MTCA threshold criteria.

**Use of Permanent Solutions and Comparative Evaluation of Alternatives**

WAC 173-340-360(3) specifies that the remediation alternatives must use permanent solutions to the maximum extent practicable. WAC 173-340-360(5) specifies that "Ecology recognizes that permanent solutions [defined at WAC 173-340-360(5)(b)] may not be practicable for all sites. A determination that a cleanup action satisfies the requirement to use permanent solutions to the maximum extent practicable is based on consideration of a number of factors." The specified factors, or criteria, are:

- Overall protectiveness
- Long-term effectiveness and reliability
- Short-term effectiveness
- Reduction in toxicity, mobility, and volume
- Implementability
- Cost
- Community acceptance

These criteria are described in Section 9.2. Selection of a remediation alternative is based on comparative evaluation of the alternatives (that satisfy the threshold criteria) using 5 permanence criteria: 1) long-term effectiveness and reliability, 2) short-term effectiveness, 3) reduction in toxicity, mobility, and volume, 4) implementability, and 5) cost. Overall protectiveness and community concerns are not included in the comparative evaluation for reasons discussed in Section 9.2.

Each alternative is scored relative to the other alternatives for the four non-cost permanence criteria. Because of the nature of the criteria and the uncertainties in the evaluation, the scores for these four criteria are expressions of relative qualitative or semi-quantitative professional judgments. A scale of 0 (worst) to 10 (best) is used. The evaluation scores are shown in Table ES-1 and discussed in Section 9.4.

The relative values of the non-cost criteria are then determined. The relative criteria values are expressions of what a scoring unit of one criterion is worth compared to a scoring unit of another criterion. The assigned relative values are converted to criteria weightings, i.e., percentage of the overall score. The scores for the four non-cost criteria are combined using the criteria weightings to give overall alternative scores. These scores express the net benefit of the alternatives. The net benefit, or overall non-cost scores, are given in Table ES-1. Using these scores, the preference ranking of the alternatives before consideration of cost is as follows (most to least preferred):

1. Alternative 5 (Low-Permeability Soil Cap)
2. Alternative 6 (FML Cap)
3. Alternative 7 (FML/GCL Cap)
4. Alternative 4 (Soil Cap)
5. Alternative 2 (Institutional Controls and Monitoring)
6. Alternative 1 (No Action)
7. Alternative 9 (Excavation and Disposal).

It should not be surprising that Alternative 9 (Excavation and Disposal) has an overall score less than Alternative 1 (No Action). This ranking reflects the many problems associated with excavation and the uncertain benefit (i.e., lack of reliability). Alternative 9 (Excavation and Disposal) would be much more likely than Alternative 1 (No Action) to cause actual harm to humans in the form of construction accidents for site workers and traffic accidents in the community. It would also be much more likely to cause exposure to waste constituents, meaning greater risk to both human and ecological receptors. These known risks must be balanced against the potential risks of no action.

After the non-cost evaluation, a comparison of the cost and benefit of the alternatives is made. Under WAC 173-340-360(5)(d)(vi), “a cleanup action shall not be considered practicable if the incremental cost of the cleanup action is substantial and disproportionate to the incremental degree of protection it would achieve over a lower preference cleanup action.” Thus, the alternative with the highest ratio of incremental benefit to incremental cost is the preferred alternative. As show in Table ES-1, Alternative 5 (Low-Permeability Soil Cap) provides the best incremental cost-effectiveness of the alternatives.

**Conclusion**

Alternative 5 (Low-Permeability Soil Cap) provides the best incremental cost-effectiveness, in addition to providing the best net benefit. Alternative 5 meets all threshold criteria (protection of human health and the environment, compliance with cleanup standards, compliance with ARARs, and provision for compliance monitoring). It provides the optimum combination of long-term effectiveness and reliability, short-term effectiveness, implementability, and reduction of toxicity, mobility, and volume. In addition, this alternative provides good cost-effectiveness. Considering the criteria and approach specified in WAC 173-340-360(5), Alternative 5 is the remediation alternative for the Landsburg Mine site that is "permanent to the maximum extent practicable", and is therefore the preferred alternative.

TABLE ES-1

## ACRONYMS

| | |
|---|---|
| ARAR | applicable or relevant and appropriate requirement |
| ARI | Analytical Resources Inc. |
| BGS | below ground surface |
| CAP | Cleanup Action Plan |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| CFR | Code of Federal Regulations |
| CLP | Contract Laboratory Program |
| COC | contaminants of concern |
| COPC | contaminants of potential concern |
| CQA | construction quality assurance |
| DNR | Washington State Department of Natural Resources |
| DNS | Determination of Nonsignificance |
| DQO | Data Quality Objective |
| EA | Environmental Assessment |
| Ecology | Washington State Department of Ecology |
| EDR | Environmental Data Resources |
| EIS | Environmental Impact Statement |
| EMI | electromagnetic inductance |
| EPA | United States Environmental Protection Agency |
| ERA | Expedited Response Action |
| FID | flame ionization detector |
| FML | flexible membrane liner |
| FS | feasibility study |
| GCL | geosynthetic clay liner |
| gpm | gallons per minute |
| GPR | ground penetrating radar |
| HQ | hazard quotient |
| KCC | King County Code |
| LICR | lifetime incremental cancer risk |
| LMW | Landsburg Monitoring Well |
| MCL | Maximum Contaminant Level |
| MCLG | Maximum Contaminant Level Goal |
| MFS | Minimum Functional Standards |
| MSL | mean sea level |
| MTCA | Model Toxics Control Act |
| NCP | National Oil and Hazardous Substances Contingency Plan |
| NEPA | National Environmental Policy Act |
| NGVD | national geodetic vertical datum |
| NPL | National Priorities List |
| OSHA | Occupational Safety and Health Administration |
| OSM | Office of Surface Mining |
| OVA | organic vapor analyzer |

**ACRONYMS** (Cont.)

| | |
|---|---|
| OVM | organic vapor monitor |
| PAH | polynuclear aromatic hydrocarbon |
| PCB | polychlorinated biphenyls |
| PCC | Palmer Coking Coal Company |
| PDF | probability distribution function |
| PHS/HRTG | Priority Habitat and Species and Natural Wildlife Heritage Data Maps |
| PID | photo-ionization detector |
| PLP | Potentially Liable Party |
| PLPSC | Potentially Liable Party Steering Committee |
| POTW | publicly-owned treatment works |
| PQL | practical quantification limit |
| PSAPCA | Puget Sound Air Pollution Control Authority |
| QA | quality assurance |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| RAO | remedial action objective |
| RCRA | Resource Conservation and Recovery Act |
| RCW | Revised Code of the State of Washington |
| RI | remedial investigation |
| SARA | Superfund Amendments and Reauthorization Act |
| SDWA | Safe Drinking Water Act |
| SDG | Sample Delivery Group |
| SEPA | State Environmental Policy Act |
| SHA | Site Hazard Assessment |
| SIDS | Sample Integrity Data Sheets |
| SMCL | Secondary Maximum Contaminant Level |
| SVOA | semi-volatile organics analysis |
| TAL | target analyte list |
| TBC | To Be Considered |
| TCE | trichloroethene |
| TCL | target compound list |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TDS | total dissolved solids |
| TPH | total petroleum hydrocarbon |
| TSCA | Toxic Substances Control Act |
| USGS | United States Geological Survey |
| UCL | upper confidence limit |
| UTL | upper tolerance limit |
| VOA | volatile organic analysis |
| VOC | volatile organic compound |
| WAC | Washington Administrative Code |
| WDOE | Washington State Department of Ecology |
| WDOH | Washington State Department of Health |
| WDW | Washington State Department of Wildlife |

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